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ISO/TC 102/SC 2/WG 21B
IRON ORES - DETERMINATION OF NICKEL AND/OR CHROMIUM CONTENT BY FLAME ATOMIC ABSORPTION METHOD

STATISTICAL ANALYSIS OF INTERNATIONAL TEST DATA - 1986

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(For submission to the Convener of ISO/TC 102/SC 2/WG 21B , to the Secretariat of ISO/TC 102/SC 2 and for presentation at the ISO/TC 102/SC 2 meeting to be held in Tokyo, Japan, 1986-11-10/14)

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IRON ORES - DETERMINATION OF NICKEL AND/OR CHROMIUM CONTENT BY FLAME ATOMIC ABSORPTION METHOD

STATISTICAL ANALYSIS OF INTERNATIONAL TEST DATA - 1986

by

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SUMMARY

The analytical data resulting from the international test on the determination of Ni and Cr by flame atomic absorption method conducted by ISO/TC 102/SC 2/WG 21B during the period of 1984-1986 have been statistically evaluated. Based on these analytical results, the precision of the analytical method can be expressed in terms of the Ni and Cr concentration level by the following equations:

Ni	Cr
$r = 0.0291\,X + 0.0007$	$r = 0.0493\,X + 0.0005$
$P = 0.0895\,X + 0.0011$	$P = 0.1022\,X + 0.0002$
$s_r = 0.0103\,X + 0.0002$	$s_r = 0.0173\,X + 0.0002$
$s_L = 0.0307\,X + 0.0003$	$s_L = 0.0344\,X + 0.0000$

where X is the Ni or Cr concentration in the sample, r is the repeatability, P is the permissible tolerance, s_r is the within-laboratory standard deviation and s_L is the between-laboratories

standard deviation, all expressed in percent. Five samples containing Ni and Cr ranging from 0.002 to 0.08% and 0.003 to 0.05%, respectively, were used in this international test. Fifteen laboratories participated in this test.

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ISO/TC 102/ SC 2/WG 21 B(WG12 - 86/3)
Octobre 1986

ISO/TC 102/ SC 2/WG 21 B

MINERAIS DE FER - DOSAGE DE LA TENEUR EN NICKEL ET/OU EN CHROME PAR LA MÉTHODE D'ANALYSE PYROGNOSTIQUE D'ABSORPTION ATOMIQUE

ÉVALUATION STATISTIQUE DES DONNÉES D'UN ESSAI INTERNATIONAL - 1986

par

R. Sutarno* et W.S. Bowman**

RÉSUMÉ

On a évalué statistiquement les résultats analytiques d'un essai international sur le dosage du nickel et du chrome par une méthode d'analyse pyrognostique d'absorption atomique, essai réalisé par le comité ISO/TC 102/ SC 2/WG 21 B au cours de la période de 1984-1986. En se basant sur ces résultats analytiques, on peut exprimer la précision de cette méthode analytique en fonction des concentrations de Ni et Cr à l'aide des équations suivantes:

Ni		Cr	
r	$= 0{,}0291\ X + 0{,}0007$	r	$= 0{,}0493\ X + 0{,}0005$
P	$= 0{,}0895\ X + 0{,}0011$	P	$= 0{,}1022\ X + 0{,}0002$
s_r	$= 0{,}0103\ X + 0{,}0002$	s_r	$= 0{,}0173\ X + 0{,}0002$
s_L	$= 0{,}0307\ X + 0{,}0003$	s_L	$= 0{,}0344\ X + 0{,}0000$

où X est la concentration de Ni ou Cr dans l'échantillon, r est la répétabilité, P est la tolérance admissible, s_r est l'écart-type intra-laboratoire et s_L est l'écart-type inter-laboratoire, tous exprimés en pourcentage.

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Dans cet essai international, on a utilisé cinq échantillons contenant du Ni et du Cr dont les concentrations respectives étaient comprises entre 0,002 et 0,08 % et 0,003 et 0,05 %. Quinze laboratoires ont participé à cet essai.

INTRODUCTION

This international test was conducted in accordance with Resolution 16 made at the twelfth meeting of ISO/TC 102/SC 2 held in Paris in 1984 (1).

The analytical data were collected by the convener of ISO/TC 102/SC 2/WG 21B (ISO Technical Committee 102 - Iron Ores; Sub committee 2 - Chemical Analyses; Working Group 21B - Determination of Ni and/or Cr content by flame atomic absorption method) from an international test conducted during the period of 1984-1986. Five samples with Ni and Cr contents ranging from 0.002 to 0.08% and 0.003 to 0.05% respectively were used. Fifteen laboratories provided analytical data; each analysed two bottles of samples in duplicate.

The purpose of this statistical evaluation is to provide the working group with the estimates of the precision in the form of repeatability, r, permissible tolerance P, within-laboratory, s_r, and between-laboratories standard deviations, s_L.

PRINCIPLE OF THE ANALYTICAL METHOD(2)

Decomposition of the test portion by treatment with hydrochloric and nitric acids. Removal of the major portion of the iron in the filtrate by extraction with 4-methyl-2-pentanone. Ignition of the insoluble residue, removal of silicon dioxide by evaporation with hydrofluoric and sulfuric acids. Fusion of the residue with a mixture of sodium tetraborate followed by leaching and filtration. Combination with the main solution.

Aspiration into flame of an atomic absorption spectrometer using air-acetylene burner for nickel and dinitrogen oxide-acetylene burner for chromium.

Comparison of the absorbance value obtained with those obtained from calibration solutions.

STATISTICAL EVALUATION

The analytical data were statistically evaluated by the procedure described in document ISO/TC 102/TCR 5 (3). This procedure is illustrated schematically in Figure 1.

The raw data and the detailed calculation are presented in Appendices A. They are summarized in Tables 1 and 2. The raw data are also plotted in Figures 2. The boxed points in these figures signify that the data were suspected to be outliers and were excluded from the estimation of the sample means and precisions. The letter C on the boxed points signifies that the data were suspected to be outliers due to poor precision (Cochran's test), and the letter D signifies the deviation from the sample means (Dixon's test).

The precisions estimated (s_r, s_L, r and P) are plotted against their corresponding sample means in Figures 3, and the regression equations of these precisions against sample means were computed and are presented in Tables 1. Tables 2 list the suspected outliers.

OBSERVATIONS

An ideal standard analytical method is an analytical method that can be applied by any qualified analyst with proper equipment and reagents with equal precision and accuracy. This implies that the better the method is standardized, the smaller is the s_L/s_r ratio and the fewer the number of outliers. The magnitude of within-laboratory standard deviation, itself, depends on the state of the art of the method. Experience has shown that, for a good method, the average s_L/s_r ratio is found to be about 2. Tables 1 show that the magnitude of the within-laboratory precision seems to be reasonable. Using s_L/s_r ratio of 2 as a bench mark, the observed s_L/s_r ratios for both techniques are acceptable. Tables 2 show that the number of outliers is reasonable with three laboratories (AU 1, IT 1 and IT 2) seeming to report more outliers than the normal statistical chance.

Table 3 shows a comparison between the means and precision obtained by the results of the present international test with those of the previous tests. In general, the results of the present test seem to be closer to those of the first test (1982) than to those of the second (1984).

REFERENCES

1. "Final report of the twelfth meeting of ISO/TC 102/SC 2 : Iron Ores/Chemical Analysis, Held in Paris, October 16-18,1984", ISO/TC 102/SC 2 N792, 1985-03-12.

2. "Iron ores-Determination of nickel and/or chromium content-Flame atomic absorption spectrophotometric method", Fourth working draft, ISO/TC 102/SC 2/WG 21 N 8E, April 1986 .

3. "Procedure for statistical evaluation of analytical data resulting from international tests",ISO/TC 102/TCR 5,1985-06-11.

4. "International test trial of the determination of nickel/chromium by flame atomic absorption spectrometric method", First working draft, ISO/TC 102/SC 2/N 704E, 1982-09-09.

5. "Convener's report ISO/TC 102/SC 2/WG 21A - Determination of nickel/chromium by flame atomic absorption spectrometric method", ISO/TC 102/SC 2/N 770E, 1984-09-28.

Abbreviations Used in this Report

s_r = SIGMA-R - within-laboratory standard deviation

s_L = SIGMA-L - between-laboratories standard deviation

r* = R - repeatability

$= 2.83\, s_r$

p** = permissible tolerance between laboratories

$= 2.83\left(s_L^2 + s_r^2/2\right)^{\frac{1}{2}}$

* Repeatability, r, is the value below which the absolute difference between two independent single test (analysis) results produced by a laboratory on identical material using the same equipment within a short interval of time, using the standardized test method, may be expected to be with a 95% probability.

** Permissible tolerance between laboratories, P, is the value below which the absolute difference between two means of duplicate test results on identical material obtained by operators of different laboratories using the standardized test method, may be expected to lie with a 95% probability.

KO - total number of participating laboratories

K - number of sets of laboratory results used for ANOVA

NO - total number of analytical results

N - No. of analytical results used for ANOVA

Table 1. Ni.

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR 3Y FLAME AAS METHOD --- NICKEL

SUMMARY OF PRECISIONS FOR ALL SAMPLES

ELEMENT	SAMPLE	KO	K	NO	N	MEAN(X)	REPEATABILITY	PERMISSIBLE TOLERANCE	SIGMA-R	SIGMA-L	SIGMA-L/SIGMA-R
NICKEL	79-6	14	13	56	52	.0020	.0008	.0016	.00027	.00054	1.98
NICKEL	76-17	14	12	56	48	.0488	.0018	.0029	.00064	.00092	1.43
NICKEL	81-6	14	12	56	48	.0167	.0011	.0022	.00039	.00074	1.90
NICKEL	85-13	14	14	56	56	.0108	.0012	.0031	.00041	.00106	2.59
NICKEL	85-14	14	14	56	56	.0843	.0033	.0100	.00116	.00343	2.95

THE REGRESSION EQUATIONS ARE:					CORR. COEFF.
R	=	.0291 X	+	.0007	.9835
P	=	.0895 X	+	.0011	.8904
SIGMA-R	=	.0103 X	+	.0002	.9827
SIGMA-L	=	.0307 X	+	.0003	.8793

Table 1. Cr.

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM

SUMMARY OF PRECISIONS FOR ALL SAMPLES

ELEMENT	SAMPLE	KO	K	NO	N	MEAN(X)	REPEATABILITY	PERMISSIBLE TOLERANCE	SIGMA-R	SIGMA-L	SIGMA-L/SIGMA-R
CHROMIUM	79-6	15	14	60	56	.0035	.0007	.0012	.00023	.00039	1.70
CHROMIUM	76-17	15	12	60	48	.0115	.0012	.0011	.00043	.00022	.52
CHROMIUM	81-6	15	15	60	60	.0559	.0033	.0061	.00115	.00199	1.73
CHROMIUM	85-13	15	15	60	60	.0164	.0012	.0018	.00042	.00055	1.29
CHROMIUM	85-14	15	13	60	52	.0186	.0014	.0015	.00050	.00040	.81

THE REGRESSION EQUATIONS ARE:

					CORR. COEFF.
R	=	.0493 X	+	.0005	.9956
P	=	.1022 X	+	.0002	.9754
SIGMA-R	=	.0173 X	+	.0002	.9954
SIGMA-L	=	.0344 X	+	.0000	.9604

Table 2. Ni.

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL

LIST OF OUTLIERS

ELEMENT	SAMPLE	COCHRAN (PRECISION)	DIXON (ACCURACY)	LAB HAS ONLY ONE RESULT	INDIVIDUAL OUTLYING RESULT (DIXON)
NICKEL	79-6	JP 1	-	-	-
NICKEL	76-17	FR 2 IT 2	- -	- -	- -
NICKEL	81-6	IT 2	IT 1	-	-
NICKEL	85-13	-	-	-	-
NICKEL	85-14	-	-	-	-

Table 2. Cr.

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM

LIST OF OUTLIERS

ELEMENT	SAMPLE	COCHRAN (PRECISION)	DIXON (ACCURACY)	LAB HAS ONLY ONE RESULT	INDIVIDUAL OUTLYING RESULT (DIXON)
CHROMIUM	79-6	IT 1	-	-	-
CHROMIUM	76-17	SU 2	AU 1	-	-
		SU 3	-	-	-
CHROMIUM	81-6	-	-	-	-
CHROMIUM	85-13	-	-	-	-
CHROMIUM	85-14	-	AU 1	-	-
		-	IT 2	-	-

Table 3

ISO/TC 102/SC 2/WG 21B
IRON ORES - DETERMINATION OF NICKEL AND/OR CHROMIUM CONTENT
BY FLAME ATOMIC ABSORPTION METHOD
Comparison between the means and precision of analytical results
obtained from the present and those from the previous international tests (4,5).

Sample No	Mean			r			P		
	1982	1984	1986	1982	1984	1986	1982	1984	1986
				Ni					
79-6	0.0019	0.0027	0.0020	0.0003	0.0010	0.0008	0.0013	0.0055	0.0016
Ratio*	1.00	1.42	1.05	1.00	3.33	2.67	1.00	4.23	1.23
76-17	0.0477	0.0515	0.0488	0.0020	0.0017	0.0018	0.0040	0.0098	0.0029
Ratio	1.00	1.08	1.02	1.00	0.85	0.90	1.00	2.45	0.72
81-6	0.0167	0.0184	0.0167	0.0014	0.0023	0.0011	0.0022	0.0051	0.0022
Ratio	1.00	1.10	1.00	1.00	1.64	0.79	1.00	2.32	1.00
				Cr					
79-6	0.0036	0.0036	0.0035	0.0005	0.0009	0.0007	0.0007	0.0024	0.0012
Ratio	1.00	1.00	0.97	1.00	1.80	1.40	1.00	3.43	1.71
76-17	0.0122	0.0120	0.0115	0.0031	0.0025	0.0012	0.0025	0.0031	0.0011
Ratio	1.00	0.98	0.94	1.00	0.81	0.39	1.00	1.24	0.44
81-6	0.0530	0.0576	0.0559	0.0049	0.0036	0.0033	0.0306	0.0064	0.0061
Ratio	1.00	1.09	1.05	1.00	0.73	0.67	1.00	0.21	0.20

*Ratio - ratio of results obtained in 1984 or 1986 to those obtained in 1982.

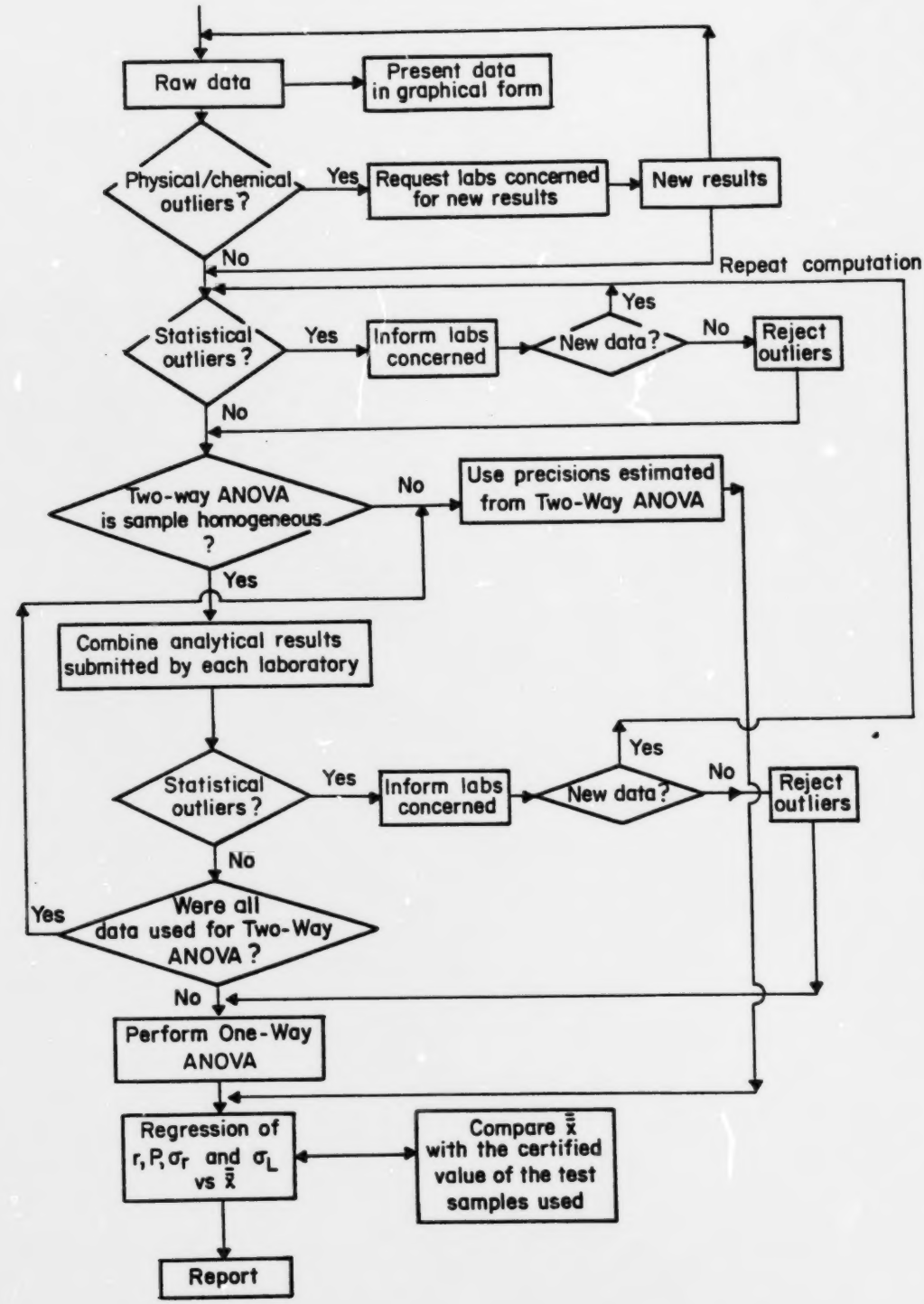


Figure 1. Flow chart of the Procedure for Statistical Evaluation of Analytical Data Resulting from International Tests.

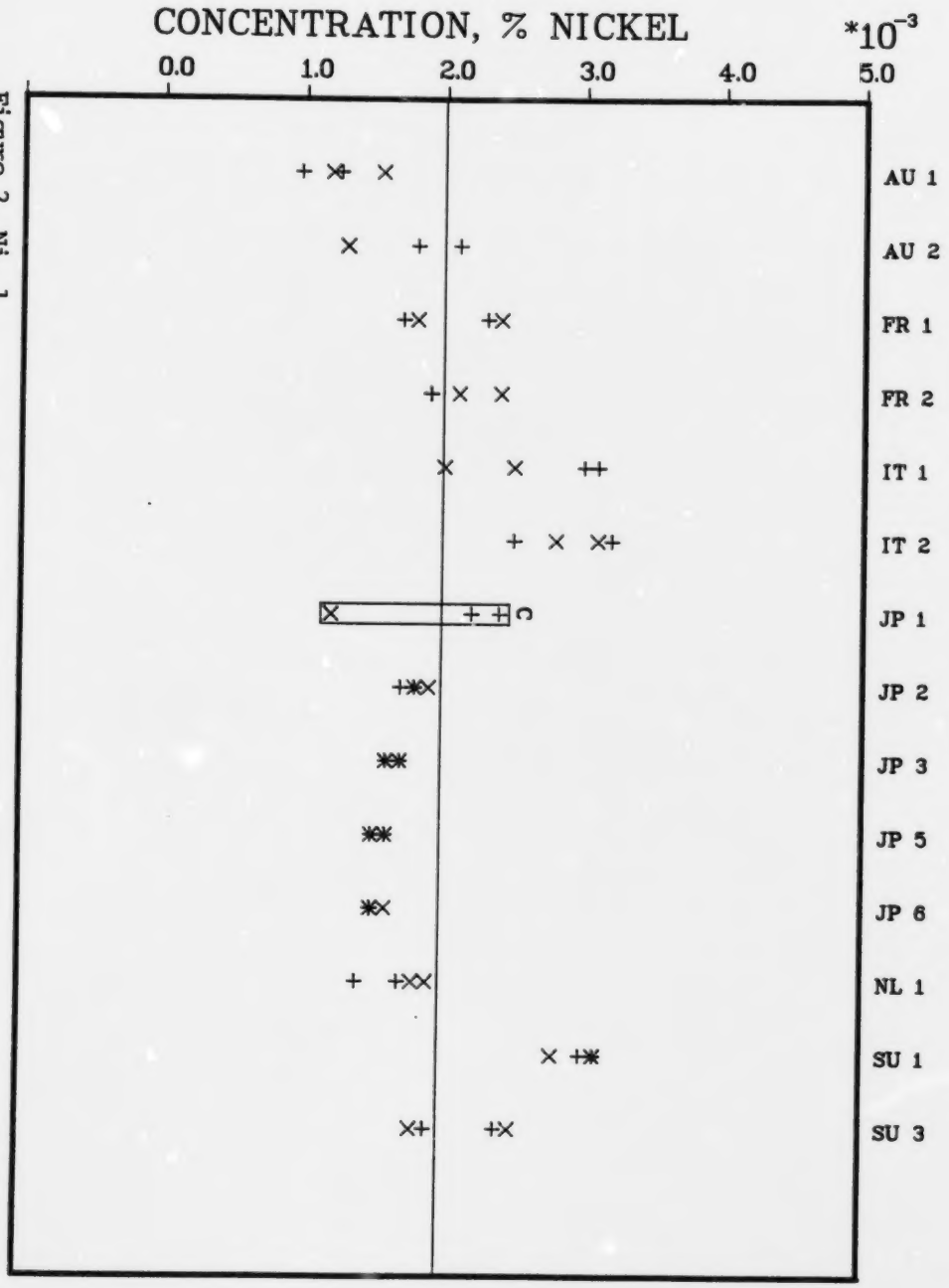


Figure 2. Ni. 1

ISO/TC 102/SC 2/WG 21B 1986 —— NI/CR BY FLAME AAS METHOD —— NICKEL

SAMPLE: 79-6

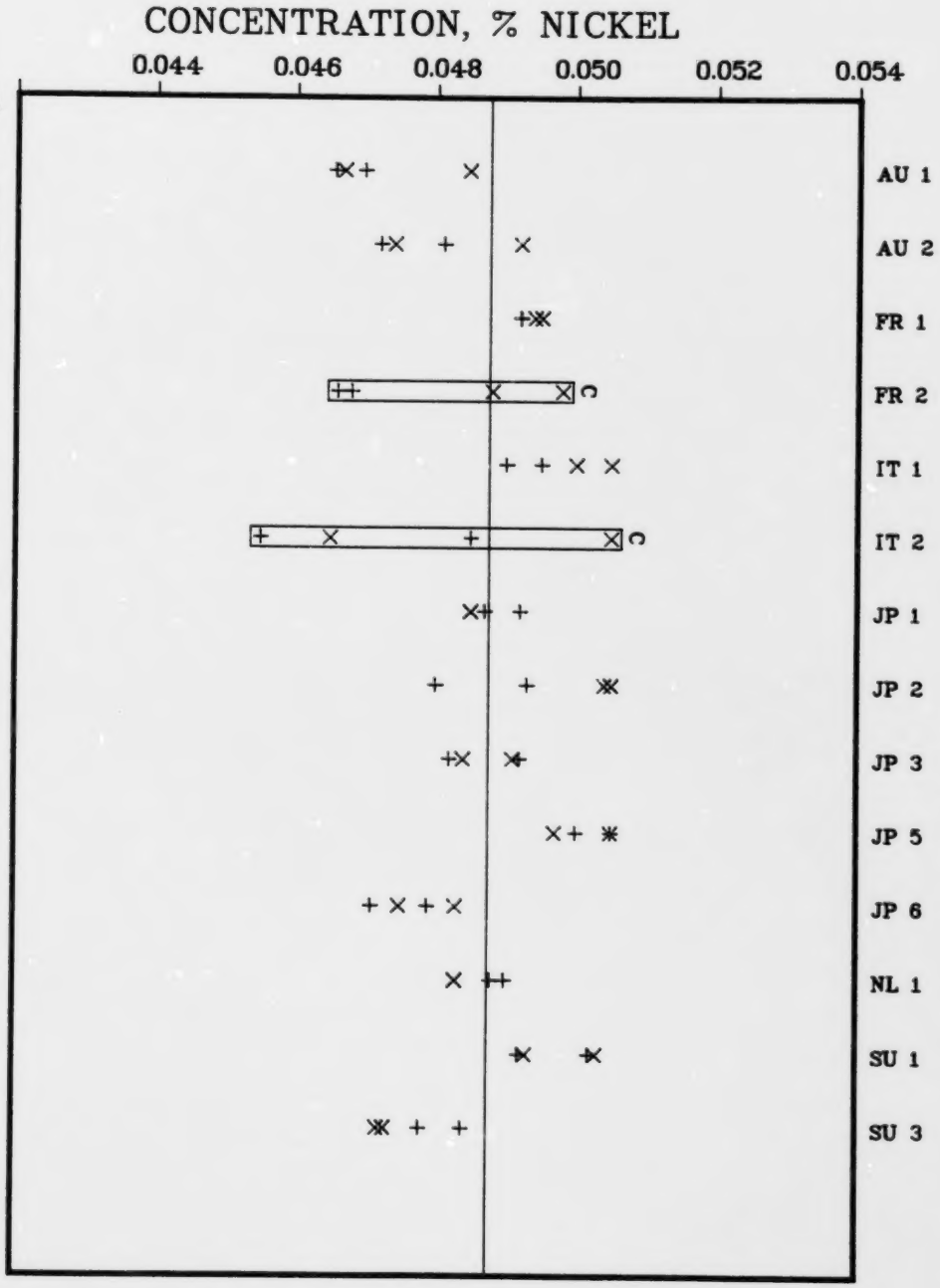


Figure 2. Ni. 2

ISO/TC 102/SC 2/WG 2IB 1986 ---- NI/CR BY FLAME AAS METHOD ---- NICKEL

SAMPLE: 76-17

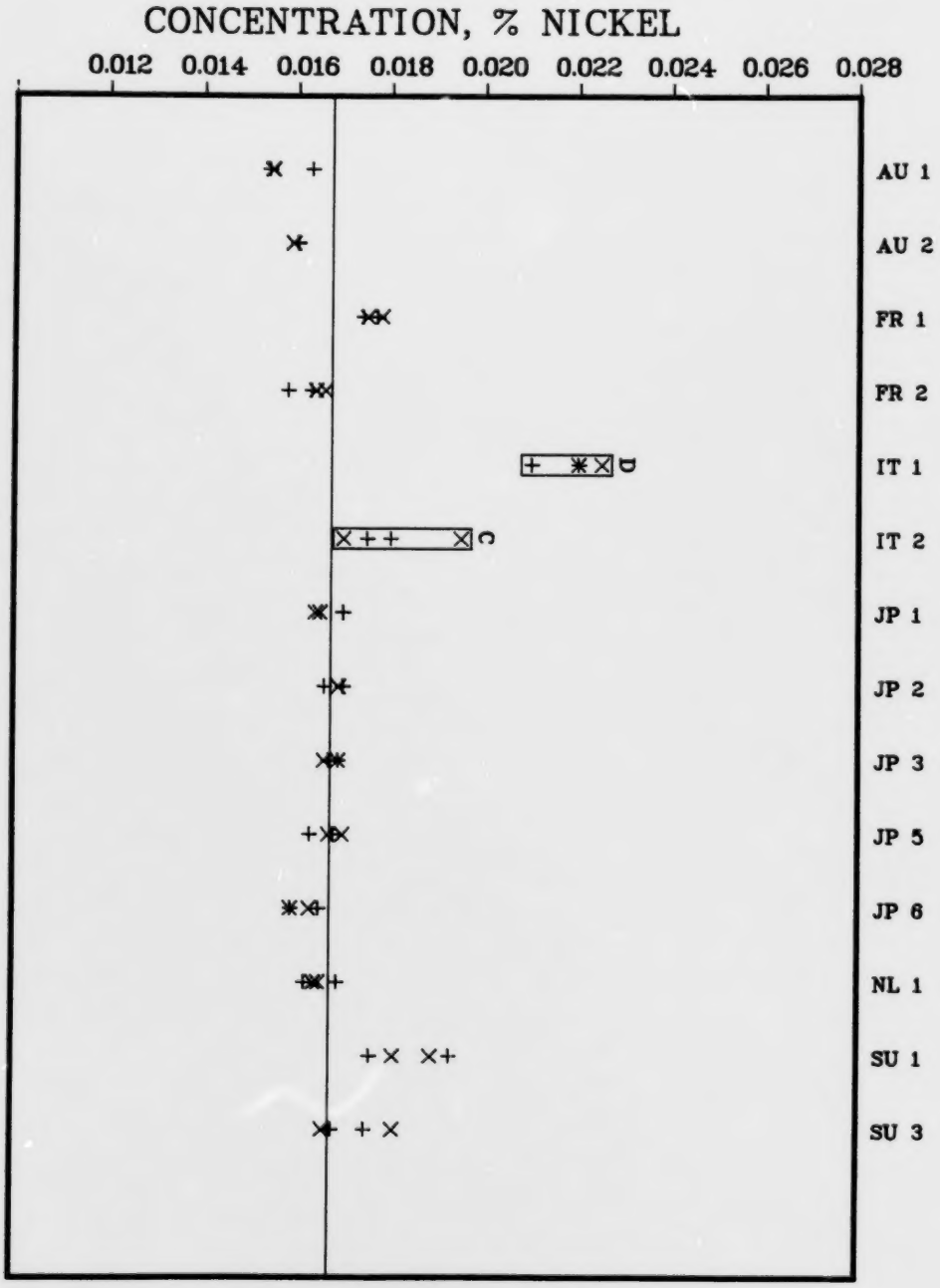


Figure 2. Ni. 3

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL

SAMPLE: 81-6

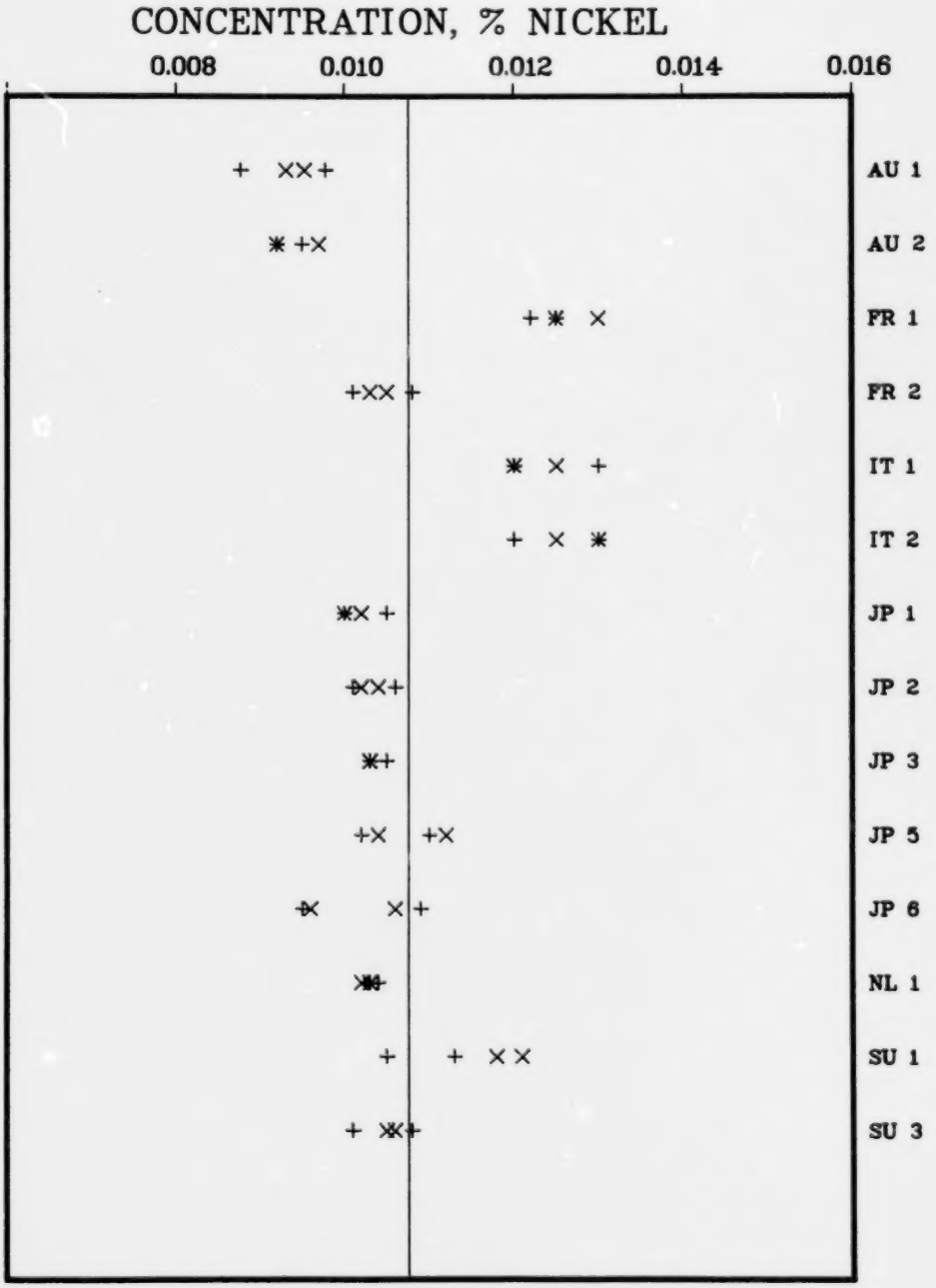


Figure 2. Ni. 4

ISO/TC 102/SC 2/WG 21B 1986 ---- NI/CR BY FLAME AAS METHOD ---- NICKEL

SAMPLE: 85-13

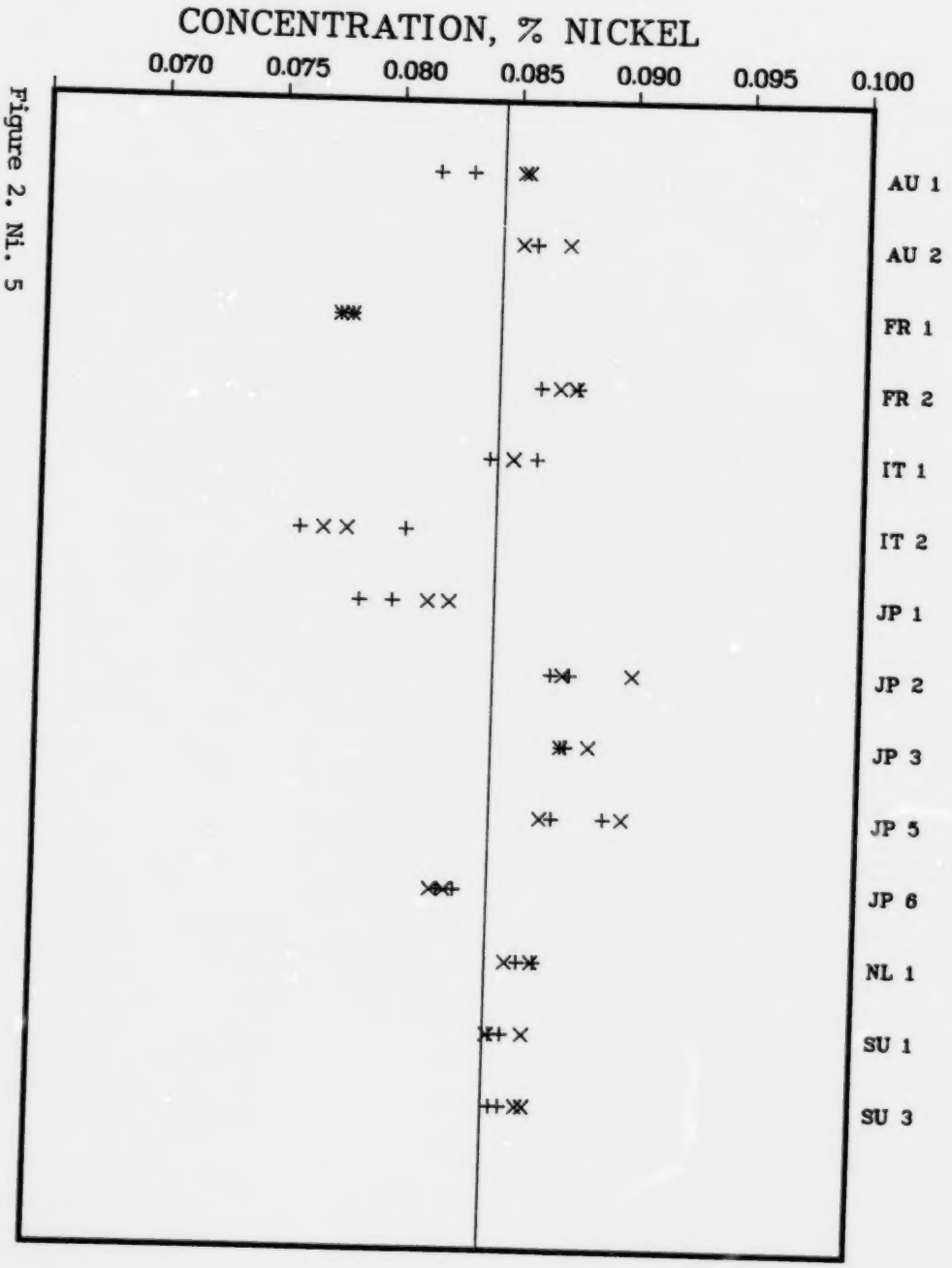


Figure 2. Ni. 5

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL

SAMPLE: 85-14

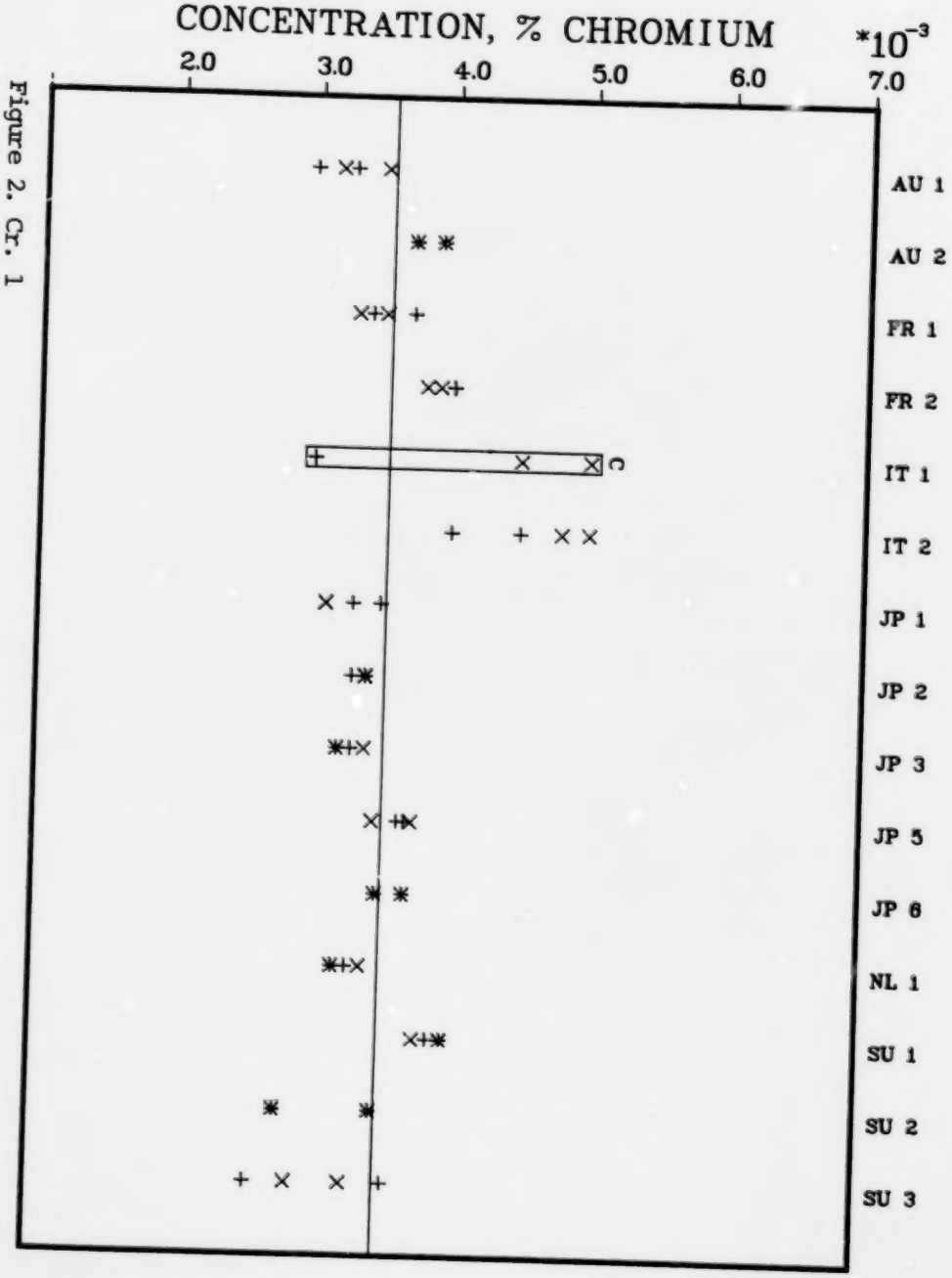


Figure 2. Cr. 1

ISO/TC 102/SC 2/WG 21B 1986 ---- NI/CR BY FLAME AAS METHOD ---- CHROMIUM

SAMPLE: 79-6

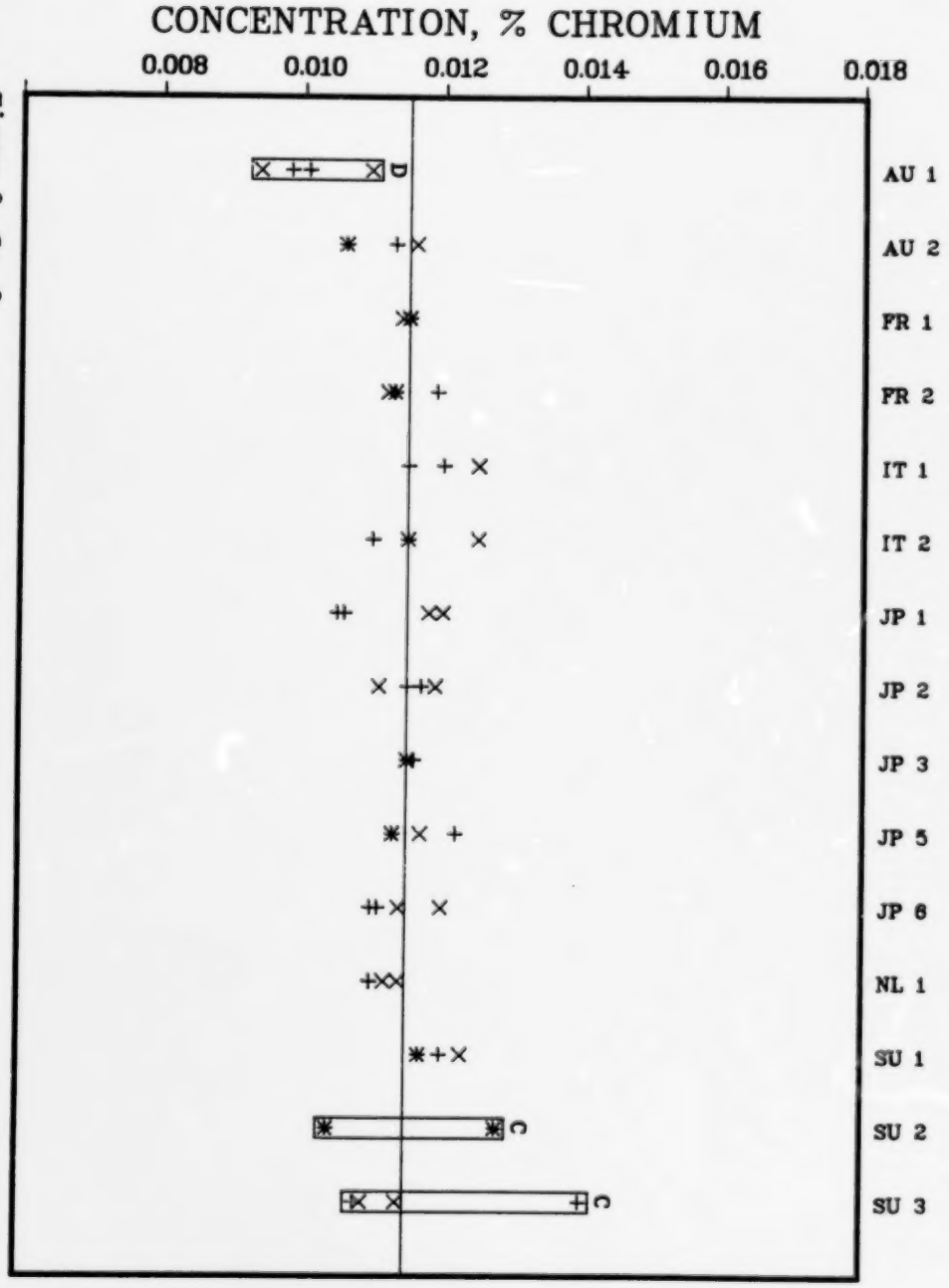


Figure 2. Cr. 2

ISO/TC 102/SC 2/WG 21B 1986 —— NI/CR BY FLAME AAS METHOD —— CHROMIUM

SAMPLE: 76-17

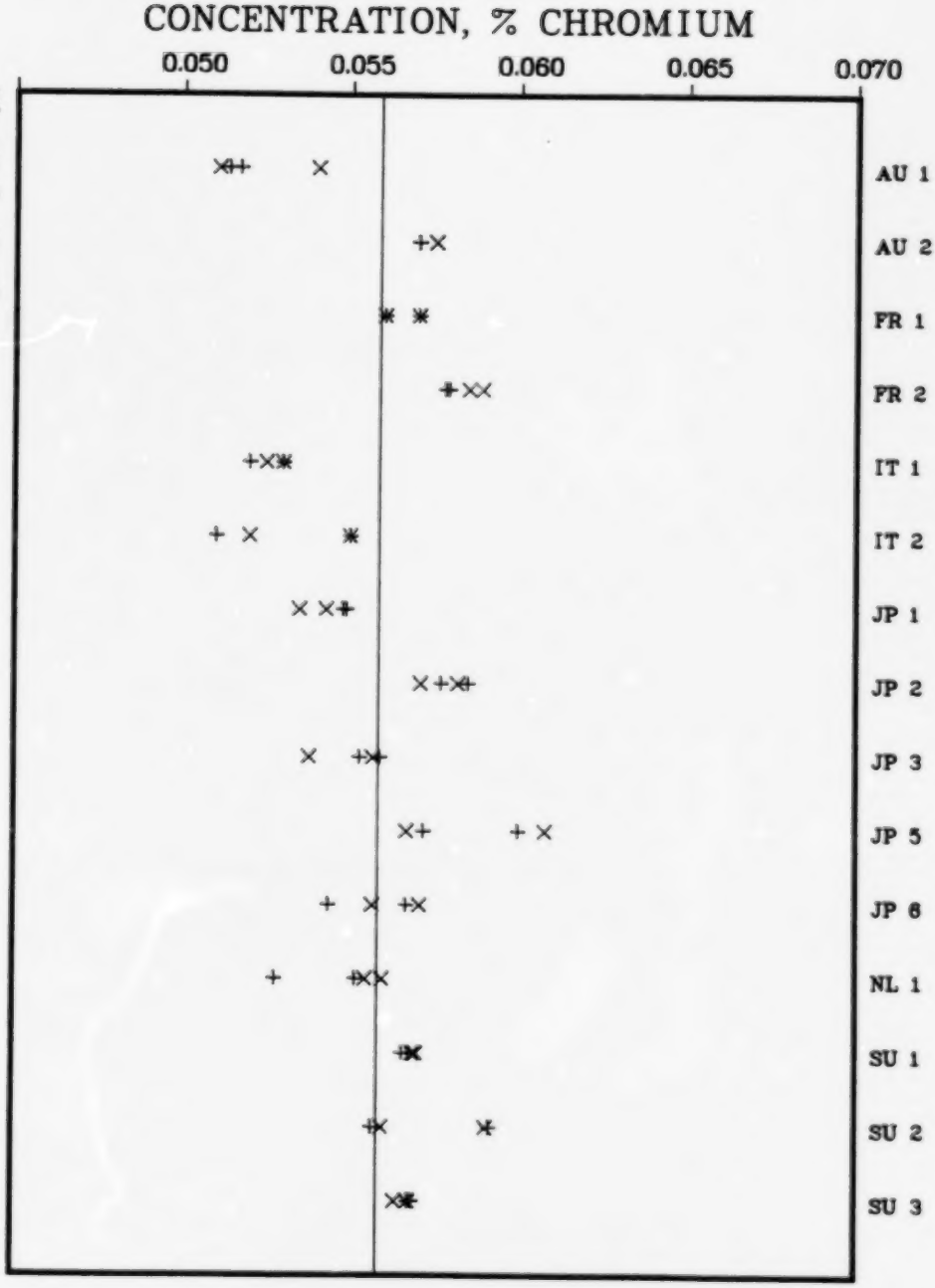


Figure 2. Cr. 3

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM

SAMPLE: 81-6

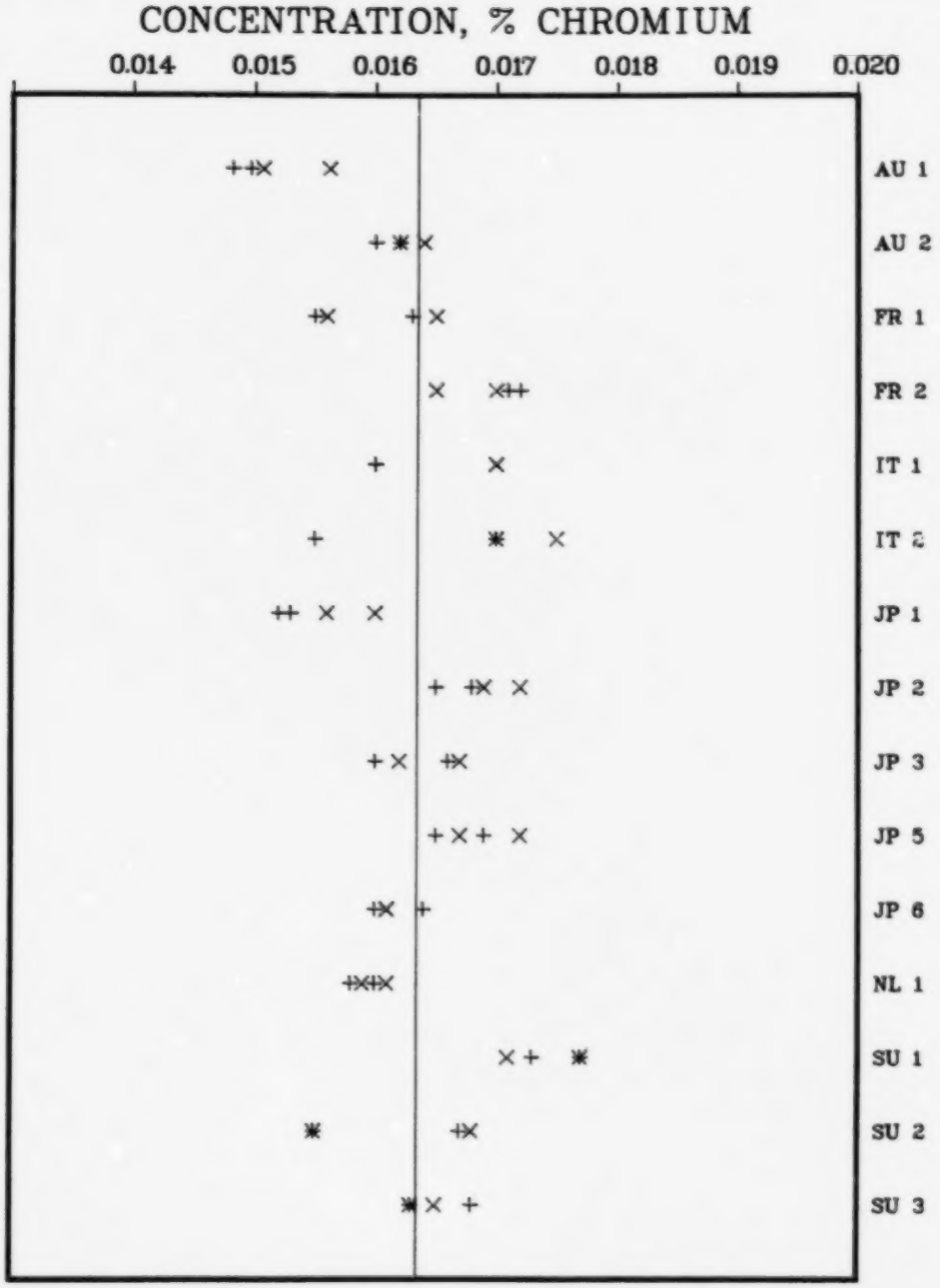


Figure 2. Cr. 4

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM

SAMPLE: 85-13

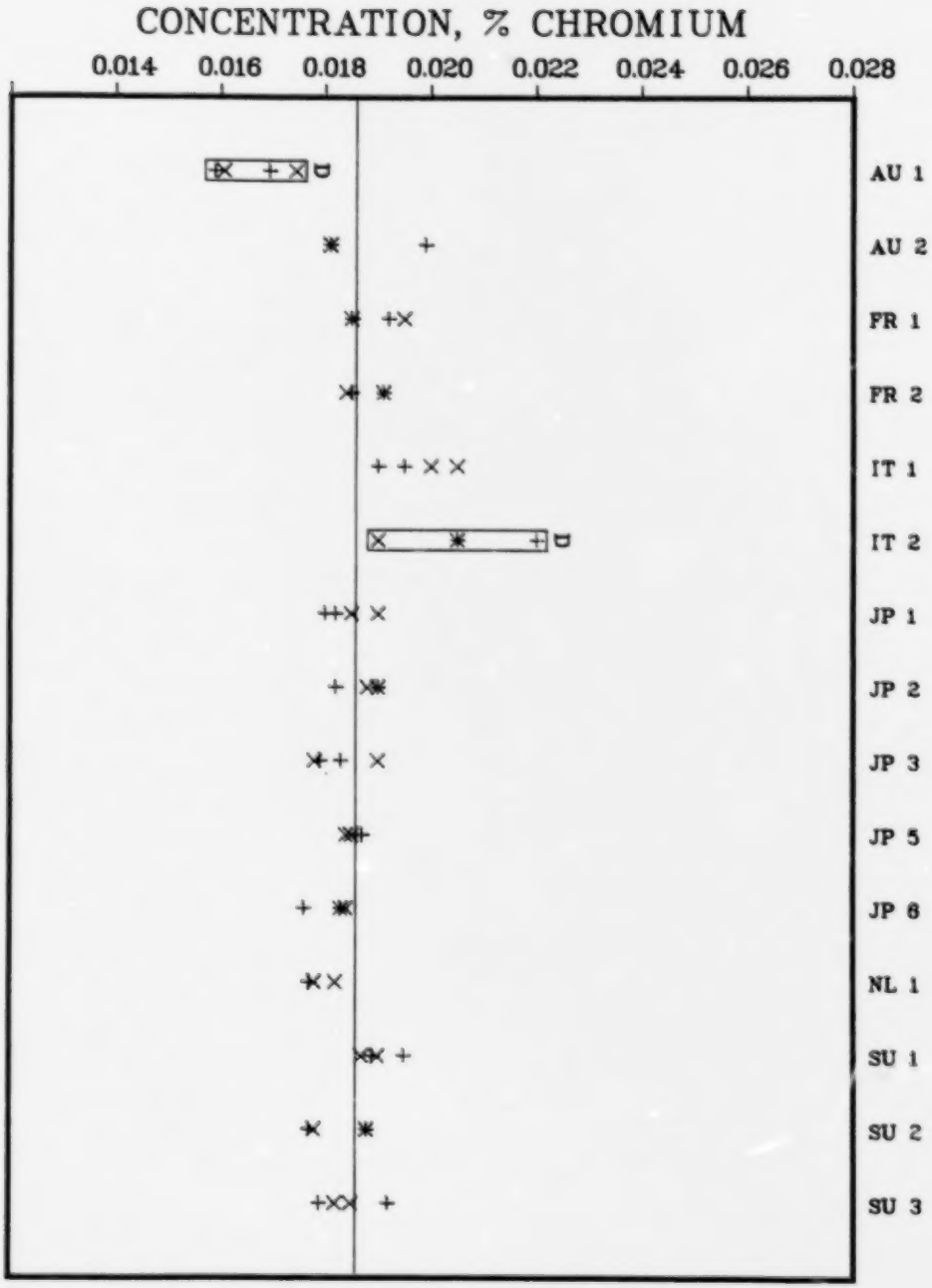
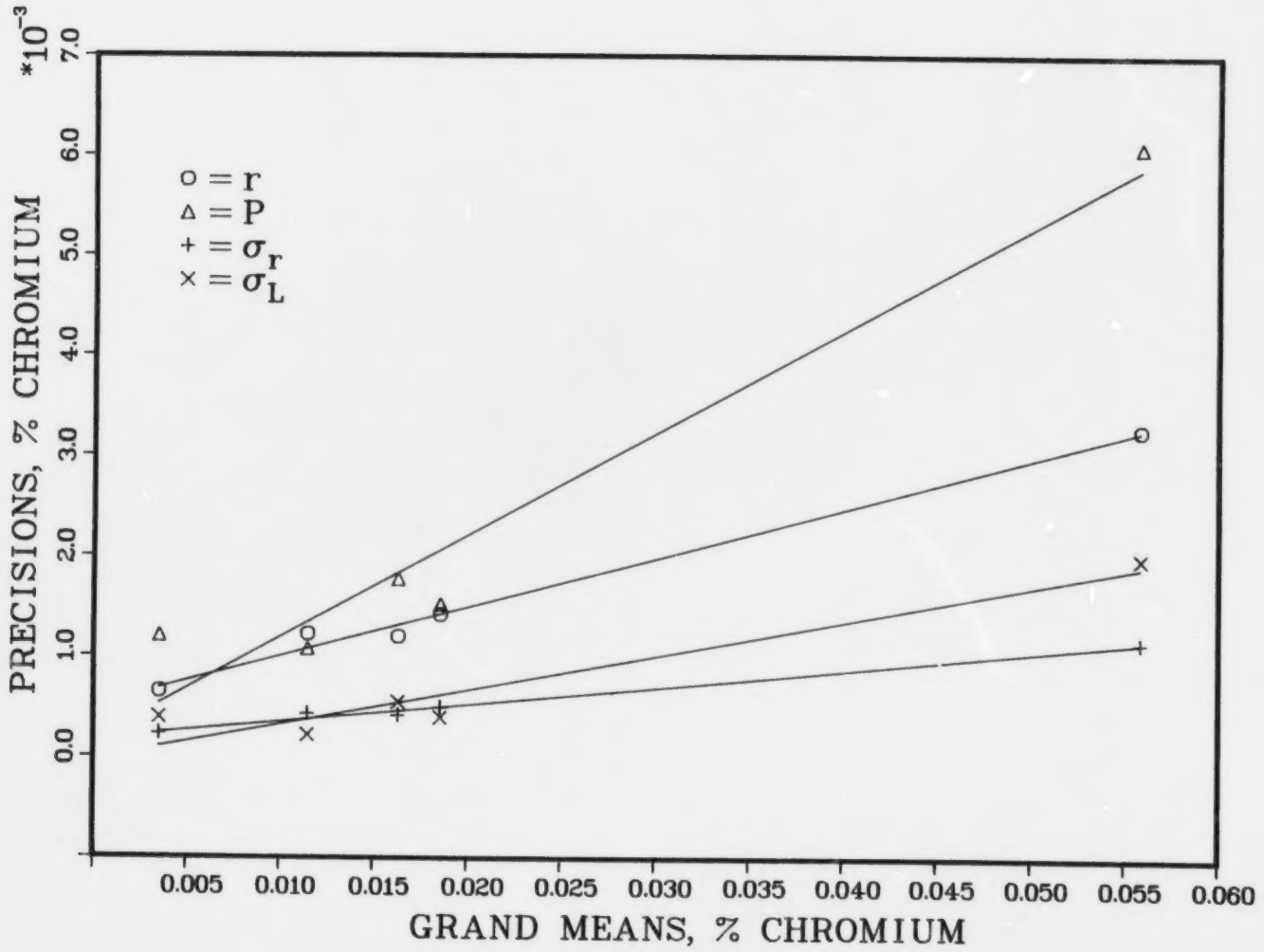


Figure 2. Cr. 5

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM

SAMPLE: 85-14

Figure 3. Cr.



ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM

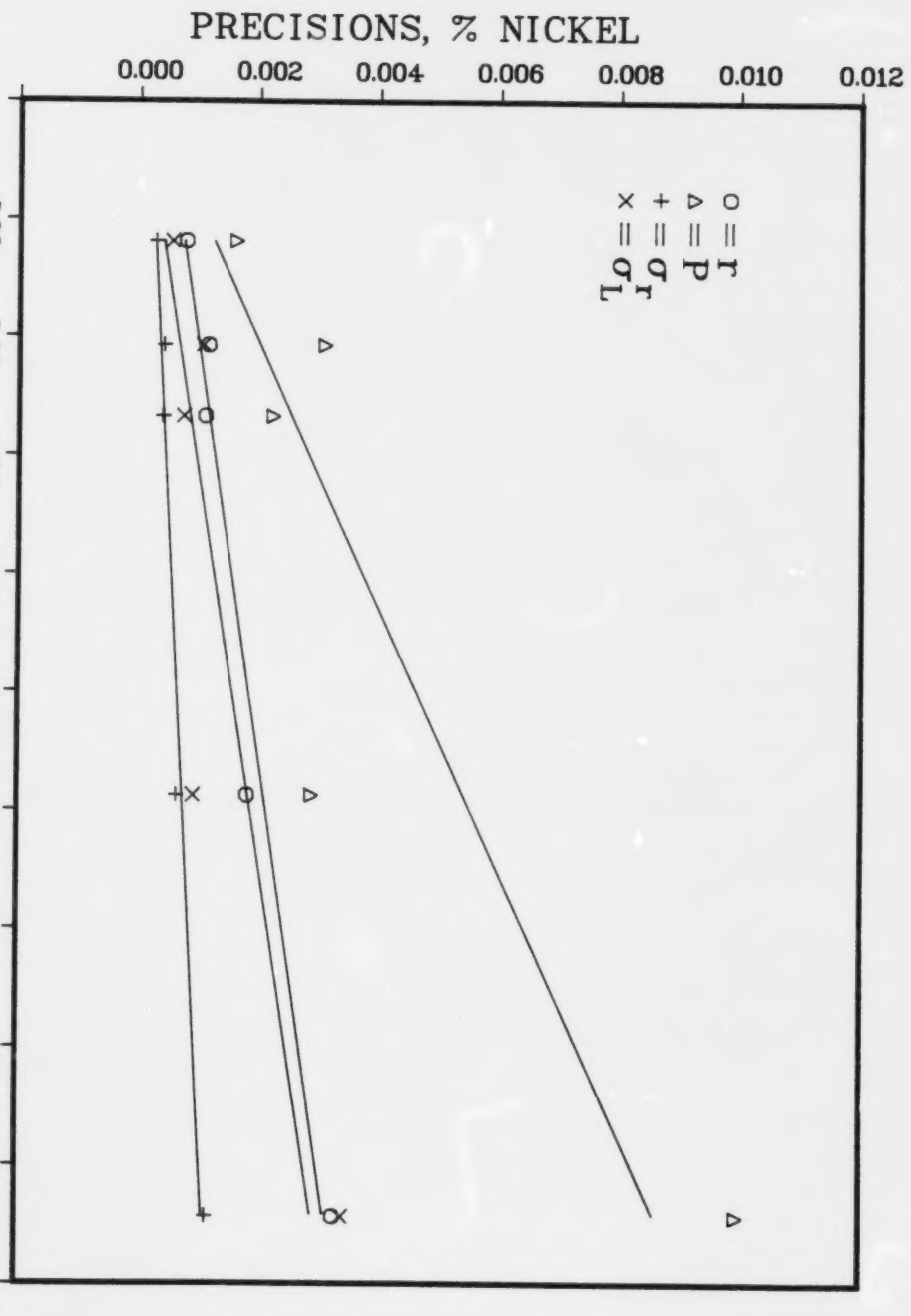


Figure 3. Ni.

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL

ISO/TC 102/SC 2/WG 21B

IRON ORES - DETERMINATION OF NICKEL AND/OR CHROMIUM CONTENT BY FLAME ATOMIC ABSORPTION METHOD

STATISTICAL ANALYSIS OF INTERNATIONAL TEST DATA - 1986

Appendix A. Ni

Detailed Computation of the Analytical Data

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 79-6

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS NICKEL		LAB MEAN	LAB VARIANCE
1	AU 1	1	.0012	.0016	.00124	.5720E-07
		2	.0010	.0013		
2	AU 2	1	.0013	.0013	.00163	.1558E-06
		2	.0021	.0018		
3	FR 1	1	.0018	.0024	.00205	.1233E-06
		2	.0017	.0023		
4	FR 2	1	.0024	.0021	.00208	.5583E-07
		2	.0019	.0019		
5	IT 1	1	.0020	.0025	.00265	.2567E-06
		2	.0030	.0031		
6	IT 2	1	.0028	.0031	.00290	.1000E-06
		2	.0025	.0032		
7	JP 1	1	.0012	.0012	.00175	.4100E-06
		2	.0024	.0022		
8	JP 2	1	.0019	.0018	.00180	.6667E-08
		2	.0018	.0017		
9	JP 3	1	.0016	.0017	.00165	.3333E-08
		2	.0016	.0017		
10	JP 5	1	.0016	.0015	.00155	.3333E-08
		2	.0016	.0015		
11	JP 6	1	.0016	.0015	.00153	.2500E-08
		2	.0015	.0015		
12	NL 1	1	.0018	.0019	.00170	.4667E-07
		2	.0017	.0014		
13	SU 1	1	.0028	.0031	.00300	.2000E-07
		2	.0030	.0031		
14	SU 3	1	.0018	.0025	.00215	.1233E-06
		2	.0019	.0024		

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 79-6

BARTLETT'S TEST FOR HOMOGENEITY OF BOTTLE VARIANCE

CALCULATED STATISTIC	14.778
CHI-SQUARE(.95,19)	30.148

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DOORNBOS' TEST FOR BOTTLE MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR TWO-WAY ANOVA

AU 2	ZERO WITHIN-BOTTLE VARIANCE
FR 2	ZERO WITHIN-BOTTLE VARIANCE
JP 1	ZERO WITHIN-BOTTLE VARIANCE
JP 6	ZERO WITHIN-BOTTLE VARIANCE

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 79-6

TWO-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	9	.12969960E-04	.14411067E-05
BETWEEN BOTTLES	10	.83760000E-06	.83760000E-07
WITHIN BOTTLES	20	.13840000E-05	.69200000E-07
TOTAL	39	.15191560E-04	

F-CALC = 1.210 F-CRIT(.95;10,20) = 2.348

TEST SAMPLE IS HOMOGENEOUS

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 79-6

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	35.221
CHI-SQUARE(.95,13)	22.367

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

JP 1 C-CALC = .300 C-CRIT(4,14) = .291

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

JP 1 COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 79-6

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	12	.14645677E-04	.12204731E-05
WITHIN LABS	39	.28641000E-05	.73438462E-07
TOTAL	51	.17509777E-04	

REPEATABILITY VARIANCE	.73438462E-07
REPEATABILITY STD. DEV.	.00027100
BETWEEN-LABORATORIES VARIANCE	.28675865E-06
BETWEEN-LABORATORIES STD. DEV.	.00053550
REPEATABILITY	.00076692
PERMISSIBLE TOLERANCE BETWEEN LABS	.00160957
GRAND MEAN	.00199346
VARIANCE OF THE GRAND MEAN	.23470636E-07

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 76-17

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS NICKEL		LAB MEAN	LAB VARIANCE
1	AU 1	1	.0467	.0485	.04717	.7762E-06
		2	.0470	.0466		
2	AU 2	1	.0492	.0474	.04798	.8158E-06
		2	.0481	.0472		
3	FR 1	1	.0494	.0495	.04933	.2250E-07
		2	.0492	.0492		
4	FR 2	1	.0498	.0488	.04800	.2427E-05
		2	.0466	.0468		
5	IT 1	1	.0500	.0505	.04975	.4167E-06
		2	.0490	.0495		
6	IT 2	1	.0465	.0505	.04775	.4917E-05
		2	.0485	.0455		
7	JP 1	1	.0485	.0485	.04873	.1092E-06
		2	.0492	.0487		
8	JP 2	1	.0505	.0504	.04955	.1363E-05
		2	.0493	.0480		
9	JP 3	1	.0484	.0491	.04873	.2492E-06
		2	.0482	.0492		
10	JP 5	1	.0497	.0505	.05018	.1558E-06
		2	.0500	.0505		
11	JP 6	1	.0475	.0483	.04770	.2667E-06
		2	.0471	.0479		
12	NL 1	1	.0483	.0483	.04860	.1267E-06
		2	.0488	.0490		
13	SU 1	1	.0503	.0493	.04975	.3367E-06
		2	.0502	.0492		
14	SU 3	1	.0472	.0473	.04768	.3025E-06
		2	.0478	.0484		

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 76-17

BARTLETT'S TEST FOR HOMOGENEITY OF BOTTLE VARIANCE

CALCULATED STATISTIC	20.641
CHI-SQUARE(.95,21)	32.678

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DOORNBOS' TEST FOR BOTTLE MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR TWO-WAY ANOVA

FR 1	ZERO WITHIN-BOTTLE VARIANCE
JP 1	ZERO WITHIN-BOTTLE VARIANCE
NL 1	ZERO WITHIN-BOTTLE VARIANCE

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 76-17

TWO-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	10	.44913000E-04	.44913000E-05
BETWEEN BOTTLES	11	.15246100E-04	.13860091E-05
WITHIN BOTTLES	22	.20832400E-04	.94692727E-06
TOTAL	43	.80991500E-04	

F-CALC = 1.464 F-CRIT(.95;11,22) = 2.259

TEST SAMPLE IS HOMOGENEOUS

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 76-17

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	31.214
CHI-SQUARE(.95,13)	22.367

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

IT 2	C-CALC = .400	C-CRIT(4,14) = .291
FR 2	C-CALC = .329	C-CRIT(4,13) = .307

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

FR 2	COCHRAN'S TEST FOR LABORATORY VARIANCE
IT 2	COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 76-17

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	11	.41579492E-04	.37799538E-05
WITHIN LABS	36	.14823500E-04	.41176389E-06
TOTAL	47	.56402992E-04	

REPEATABILITY VARIANCE	.41176389E-06
REPEATABILITY STD. DEV.	.00064169
BETWEEN-LABORATORIES VARIANCE	.84204747E-06
BETWEEN-LABORATORIES STD. DEV.	.00091763
REPEATABILITY	.00181598
PERMISSIBLE TOLERANCE BETWEEN LABS	.00289703
GRAND MEAN	.04875958
VARIANCE OF THE GRAND MEAN	.78749037E-07

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 81-6

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS NICKEL		LAB MEAN	LAB VARIANCE
1	AU 1	1	.0154	.0155	.01565	.1918E-06
		2	.0163	.0154		
2	AU 2	1	.0159	.0159	.01595	.3333E-08
		2	.0160	.0160		
3	FR 1	1	.0175	.0178	.01760	.3333E-07
		2	.0174	.0177		
4	FR 2	1	.0166	.0164	.01628	.1158E-06
		2	.0158	.0163		
5	IT 1	1	.0225	.0220	.02188	.3958E-06
		2	.0220	.0210		
6	IT 2	1	.0170	.0195	.01800	.1167E-05
		2	.0175	.0180		
7	JP 1	1	.0165	.0164	.01673	.1025E-06
		2	.0170	.0170		
8	JP 2	1	.0169	.0169	.01685	.3000E-07
		2	.0170	.0166		
9	JP 3	1	.0166	.0169	.01678	.2250E-07
		2	.0169	.0167		
10	JP 5	1	.0170	.0167	.01670	.8667E-07
		2	.0168	.0163		
11	JP 6	1	.0163	.0159	.01615	.9000E-07
		2	.0165	.0159		
12	NL 1	1	.0164	.0165	.01650	.8667E-07
		2	.0169	.0162		
13	SU 1	1	.0181	.0189	.01848	.5892E-06
		2	.0176	.0193		
14	SU 3	1	.0166	.0181	.01725	.4700E-06
		2	.0168	.0175		

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 81-6

BARTLETT'S TEST FOR HOMOGENEITY OF BOTTLE VARIANCE

CALCULATED STATISTIC	21.754
CHI-SQUARE(.95,21)	32.678

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DOORNBOS' TEST FOR BOTTLE MEANS (ALPHA=.05)

IT 1	BOTTLE- 1	T-CALC = 4.293	T-CRIT(.00179,26) = 3.480
IT 1	BOTTLE- 2	T-CALC = 5.646	T-CRIT(.00185,25) = 3.481

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR TWO-WAY ANOVA

AU 2	ZERO WITHIN-BOTTLE VARIANCE
IT 1	DOORNBOS' TEST FOR BOTTLE MEANS
JP 1	ZERO WITHIN-BOTTLE VARIANCE
JP 2	ZERO WITHIN-BOTTLE VARIANCE

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 81-6

TWO-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	9	.28132840E-04	.31258711E-05
BETWEEN BOTTLES	10	.76960000E-06	.76960000E-07
WITHIN BOTTLES	20	.77884000E-05	.38942000E-06
TOTAL	39	.36690840E-04	

F-CALC = .198 F-CRIT(.95;10,20) = 2.348

TEST SAMPLE IS HOMOGENEOUS

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 81-6

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	32.084
CHI-SQUARE(.95,13)	22.367

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

IT 2 C-CALC = .345 C-CRIT(4,14) = .291

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

IT 1 R = .677 D-CRIT(14) = .587

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

IT 1 DIXON'S TEST FOR LABORATORY MEANS
IT 2 COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 81-6

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	11	.25880425E-04	.23527659E-05
WITHIN LABS	36	.54655000E-05	.15181944E-06
TOTAL	47	.31345925E-04	

REPEATABILITY VARIANCE	.15181944E-06
REPEATABILITY STD. DEV.	.00038964
BETWEEN-LABORATORIES VARIANCE	.55023662E-06
BETWEEN-LABORATORIES STD. DEV.	.00074178
REPEATABILITY	.00110268
PERMISSIBLE TOLERANCE BETWEEN LABS	.00223936
GRAND MEAN	.01674125
VARIANCE OF THE GRAND MEAN	.49015956E-07

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 85-13

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS NICKEL		LAB MEAN	LAB VARIANCE
1	AU 1	1	.0095	.0093	.00935	.1851E-06
		2	.0098	.0088		
2	AU 2	1	.0092	.0097	.00940	.6000E-07
		2	.0092	.0095		
3	FR 1	1	.0125	.0130	.01255	.1100E-06
		2	.0122	.0125		
4	FR 2	1	.0103	.0105	.01043	.8917E-07
		2	.0101	.0108		
5	IT 1	1	.0125	.0120	.01238	.2292E-06
		2	.0120	.0130		
6	IT 2	1	.0125	.0130	.01263	.2292E-06
		2	.0120	.0130		
7	JP 1	1	.0100	.0102	.01018	.5583E-07
		2	.0100	.0105		
8	JP 2	1	.0102	.0104	.01033	.4917E-07
		2	.0101	.0106		
9	JP 3	1	.0103	.0103	.01035	.1000E-07
		2	.0103	.0105		
10	JP 5	1	.0112	.0104	.01070	.2267E-06
		2	.0110	.0102		
11	JP 6	1	.0106	.0096	.01015	.4967E-06
		2	.0109	.0095		
12	NL 1	1	.0103	.0102	.01030	.6667E-08
		2	.0104	.0103		
13	SU 1	1	.0118	.0121	.01143	.4892E-06
		2	.0105	.0113		
14	SU 3	1	.0106	.0105	.01050	.8667E-07
		2	.0108	.0101		

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 85-13

BARTLETT'S TEST FOR HOMOGENEITY OF BOTTLE VARIANCE

CALCULATED STATISTIC	15.889
CHI-SQUARE(.95,25)	37.660

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DOORNBOS' TEST FOR BOTTLE MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR TWO-WAY ANOVA

JP 3	ZERO WITHIN-BOTTLE VARIANCE

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 85-13

TWO-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	12	.59450792E-04	.49542327E-05
BETWEEN BOTTLES	13	.15160250E-05	.11661731E-06
WITHIN BOTTLES	26	.54242500E-05	.20862500E-06
TOTAL	51	.66391067E-04	

F-CALC = .559 F-CRIT(.95;13,26) = 2.119

TEST SAMPLE IS HOMOGENEOUS

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 85-13

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	20.873
CHI-SQUARE(.95,13)	22.367

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 85-13

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	13	.60176809E-04	.46289853E-05
WITHIN LABS	42	.69702750E-05	.16595893E-06
TOTAL	55	.67147084E-04	

REPEATABILITY VARIANCE	.16595893E-06
REPEATABILITY STD. DEV.	.00040738
BETWEEN-LABORATORIES VARIANCE	.11157566E-05
BETWEEN-LABORATORIES STD. DEV.	.00105629
REPEATABILITY	.00115289
PERMISSIBLE TOLERANCE BETWEEN LABS	.00309848
GRAND MEAN	.01076054
VARIANCE OF THE GRAND MEAN	.82660452E-07

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 85-14

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS NICKEL		LAB MEAN	LAB VARIANCE
1	AU 1	1	.0854	.0852	.08380	.3313E-05
		2	.0830	.0816		
2	AU 2	1	.0872	.0852	.08600	.7200E-06
		2	.0858	.0858		
3	FR 1	1	.0780	.0775	.07775	.8333E-07
		2	.0780	.0775		
4	FR 2	1	.0876	.0869	.08708	.5469E-06
		2	.0861	.0877		
5	IT 1	1	.0850	.0850	.08500	.6667E-06
		2	.0860	.0840		
6	IT 2	1	.0780	.0770	.07788	.3729E-05
		2	.0760	.0805		
7	JP 1	1	.0815	.0824	.08063	.2802E-05
		2	.0800	.0786		
8	JP 2	1	.0873	.0903	.08800	.2460E-05
		2	.0868	.0876		
9	JP 3	1	.0873	.0885	.08765	.3300E-06
		2	.0873	.0875		
10	JP 5	1	.0865	.0900	.08818	.2856E-05
		2	.0870	.0892		
11	JP 6	1	.0819	.0825	.08238	.1825E-06
		2	.0829	.0822		
12	NL 1	1	.0863	.0852	.08590	.3133E-06
		2	.0864	.0857		
13	SU 1	1	.0860	.0845	.08505	.4700E-06
		2	.0851	.0846		
14	SU 3	1	.0861	.0858	.08543	.4092E-06
		2	.0847	.0851		

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 85-14

BARTLETT'S TEST FOR HOMOGENEITY OF BOTTLE VARIANCE

CALCULATED STATISTIC	21.417
CHI-SQUARE(.95,23)	35.178

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DOORNBOS' TEST FOR BOTTLE MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR TWO-WAY ANOVA

AU 2	ZERO WITHIN-BOTTLE VARIANCE
IT 1	ZERO WITHIN-BOTTLE VARIANCE

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 85-14

TWO-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	11	.61355227E-03	.55777479E-04
BETWEEN BOTTLES	12	.20932325E-04	.17443604E-05
WITHIN BOTTLES	24	.31556450E-04	.13148521E-05
TOTAL	47	.66604105E-03	

F-CALC = 1.327 F-CRIT(.95;12,24) = 2.183

TEST SAMPLE IS HOMOGENEOUS

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 85-14

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	21.811
CHI-SQUARE(.95,13)	22.367

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- NICKEL
SAMPLE: 85-14

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	13	.62819254E-03	.48322503E-04
WITHIN LABS	42	.56648775E-04	.13487804E-05
TOTAL	55	.68484131E-03	

REPEATABILITY VARIANCE	.13487804E-05
REPEATABILITY STD. DEV.	.00116137
BETWEEN-LABORATORIES VARIANCE	.11743431E-04
BETWEEN-LABORATORIES STD. DEV.	.00342687
REPEATABILITY	.00328668
PERMISSIBLE TOLERANCE BETWEEN LABS	.00997262
GRAND MEAN	.08433625
VARIANCE OF THE GRAND MEAN	.86290184E-06

ISO/TC 102/SC 2/WG 21B
IRON ORES - DETERMINATION OF NICKEL AND/OR CHROMIUM CONTENT
BY FLAME ATOMIC ABSORPTION METHOD

STATISTICAL ANALYSIS OF INTERNATIONAL TEST DATA - 1986

Appendix A. Cr

Detailed Computation of the Analytical Data

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 79-6

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS CHROMIUM		LAB MEAN	LAB VARIANCE
1	AU 1	1	.0032	.0035	.00322	.4687E-07
		2	.0030	.0033		
2	AU 2	1	.0039	.0037	.00380	.1333E-07
		2	.0037	.0039		
3	FR 1	1	.0033	.0035	.00348	.2917E-07
		2	.0034	.0037		
4	FR 2	1	.0039	.0038	.00393	.9167E-08
		2	.0040	.0040		
5	IT 1	1	.0050	.0045	.00388	.1063E-05
		2	.0030	.0030		
6	IT 2	1	.0048	.0050	.00458	.1892E-06
		2	.0040	.0045		
7	JP 1	1	.0031	.0031	.00325	.3667E-07
		2	.0035	.0033		
8	JP 2	1	.0034	.0034	.00338	.2500E-08
		2	.0033	.0034		
9	JP 3	1	.0034	.0032	.00328	.9167E-08
		2	.0033	.0032		
10	JP 5	1	.0035	.0038	.00364	.1489E-07
		2	.0037	.0037		
11	JP 6	1	.0037	.0035	.00360	.1333E-07
		2	.0035	.0037		
12	NL 1	1	.0034	.0032	.00328	.9167E-08
		2	.0033	.0032		
13	SU 1	1	.0038	.0040	.00393	.9167E-08
		2	.0039	.0040		
14	SU 2	1	.0035	.0028	.00315	.1633E-06
		2	.0035	.0028		
15	SU 3	1	.0033	.0029	.00310	.1933E-06
		2	.0036	.0026		

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 79-6

BARTLETT'S TEST FOR HOMOGENEITY OF BOTTLE VARIANCE

CALCULATED STATISTIC	15.029
CHI-SQUARE(.95,21)	32.678

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DOORNBOS' TEST FOR BOTTLE MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR TWO-WAY ANOVA

FR 2	ZERO WITHIN-BOTTLE VARIANCE
IT 1	ZERO WITHIN-BOTTLE VARIANCE
JP 1	ZERO WITHIN-BOTTLE VARIANCE
JP 2	ZERO WITHIN-BOTTLE VARIANCE

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 79-6

TWO-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	10	.75722682E-05	.75722682E-06
BETWEEN BOTTLES	11	.50082500E-06	.45529545E-07
WITHIN BOTTLES	22	.15719500E-05	.71452273E-07
TOTAL	43	.96450432E-05	

F-CALC = .637 F-CRIT(.95;11,22) = 2.259

TEST SAMPLE IS HOMOGENEOUS

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 79-6

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	55.717
CHI-SQUARE(.95,14)	23.691

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

IT 1 C-CALC = .590 C-CRIT(4,15) = .276

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

IT 1 COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 79-6

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	13	.86137089E-05	.66259299E-06
WITHIN LABS	42	.22177750E-05	.52804167E-07
TOTAL	55	.10831484E-04	

REPEATABILITY VARIANCE	.52804167E-07
REPEATABILITY STD. DEV.	.00022979
BETWEEN-LABORATORIES VARIANCE	.15244721E-06
BETWEEN-LABORATORIES STD. DEV.	.00039044
REPEATABILITY	.00065031
PERMISSIBLE TOLERANCE BETWEEN LABS	.00119682
GRAND MEAN	.00354196
VARIANCE OF THE GRAND MEAN	.11832018E-07

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 76-17

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS CHROMIUM		LAB MEAN	LAB VARIANCE
1	AU 1	1	.0094	.0110	.01005	.4434E-06
		2	.0098	.0101		
2	AU 2	1	.0106	.0116	.01103	.2558E-06
		2	.0106	.0113		
3	FR 1	1	.0114	.0115	.01148	.2500E-08
		2	.0115	.0115		
4	FR 2	1	.0113	.0112	.01143	.1025E-06
		2	.0113	.0119		
5	IT 1	1	.0125	.0125	.01213	.2292E-06
		2	.0120	.0115		
6	IT 2	1	.0125	.0115	.01163	.3958E-06
		2	.0115	.0110		
7	JP 1	1	.0118	.0120	.01123	.6158E-06
		2	.0106	.0105		
8	JP 2	1	.0119	.0111	.01155	.1167E-06
		2	.0115	.0117		
9	JP 3	1	.0115	.0115	.01153	.2500E-08
		2	.0116	.0115		
10	JP 5	1	.0113	.0117	.01163	.1825E-06
		2	.0113	.0122		
11	JP 6	1	.0120	.0114	.01138	.2025E-06
		2	.0111	.0110		
12	NL 1	1	.0112	.0114	.01115	.3667E-07
		2	.0110	.0110		
13	SU 1	1	.0123	.0117	.01193	.8250E-07
		2	.0120	.0117		
14	SU 2	1	.0128	.0104	.01160	.1920E-05
		2	.0128	.0104		
15	SU 3	1	.0109	.0114	.01178	.2269E-05
		2	.0108	.0140		

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 76-17

BARTLETT'S TEST FOR HOMOGENEITY OF BOTTLE VARIANCE

CALCULATED STATISTIC	25.733
CHI-SQUARE(.95,21)	32.678

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DOORNBOS' TEST FOR BOTTLE MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR TWO-WAY ANOVA

FR 1	ZERO WITHIN-BOTTLE VARIANCE
IT 1	ZERO WITHIN-BOTTLE VARIANCE
JP 3	ZERO WITHIN-BOTTLE VARIANCE
NL 1	ZERO WITHIN-BOTTLE VARIANCE

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 76-17

TWO-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	10	.10312114E-04	.10312114E-05
BETWEEN BOTTLES	11	.46606250E-05	.42369318E-06
WITHIN BOTTLES	22	.15099450E-04	.68633864E-06
TOTAL	43	.30072189E-04	

F-CALC = .617 F-CRIT(.95;11,22) = 2.259

TEST SAMPLE IS HOMOGENEOUS

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 76-17

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	46.554
CHI-SQUARE(.95,14)	23.691

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

SU 3	C-CALC = .331	C-CRIT(4,15) = .276
SU 2	C-CALC = .418	C-CRIT(4,14) = .291

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

AU 1	R = .638	D-CRIT(15) = .565

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

AU 1	DIXON'S TEST FOR LABORATORY MEANS
SU 2	COCHRAN'S TEST FOR LABORATORY VARIANCE
SU 3	COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 76-17

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	11	.420416[illegible]7E-05	.38219697E-06
WITHIN LABS	36	.66750000E-05	.18541667E-06
TOTAL	47	.10879167E-04	

REPEATABILITY VARIANCE	.18541667E-06
REPEATABILITY STD. DEV.	.00043060
BETWEEN-LABORATORIES VARIANCE	.49195076E-07
BETWEEN-LABORATORIES STD. DEV.	.00022180
REPEATABILITY	.00121860
PERMISSIBLE TOLERANCE BETWEEN LABS	.00106606
GRAND MEAN	.01150417
VARIANCE OF THE GRAND MEAN	.79624369E-08

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 81-6

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS CHROMIUM		LAB MEAN	LAB VARIANCE
1	AU 1	1	.0540	.0510	.05201	.1822E-05
		2	.0517	.0513		
2	AU 2	1	.0575	.0575	.05725	.8333E-07
		2	.0570	.0570		
3	FR 1	1	.0570	.0560	.05650	.3333E-06
		2	.0570	.0560		
4	FR 2	1	.0585	.0589	.05828	.2692E-06
		2	.0579	.0578		
5	IT 1	1	.0525	.0530	.05263	.2292E-06
		2	.0530	.0520		
6	IT 2	1	.0520	.0550	.05325	.4250E-05
		2	.0550	.0510		
7	JP 1	1	.0543	.0535	.05438	.4092E-06
		2	.0549	.0548		
8	JP 2	1	.0571	.0582	.05788	.3758E-06
		2	.0585	.0577		
9	JP 3	1	.0538	.0557	.05518	.9025E-06
		2	.0553	.0559		
10	JP 5	1	.0567	.0608	.05868	.4116E-05
		2	.0572	.0600		
11	JP 6	1	.0557	.0571	.05598	.1449E-05
		2	.0544	.0567		
12	NL 1	1	.0555	.0560	.05488	.2022E-05
		2	.0552	.0528		
13	SU 1	1	.0570	.0569	.05683	.2917E-07
		2	.0566	.0568		
14	SU 2	1	.0591	.0560	.05750	.3647E-05
		2	.0592	.0557		
15	SU 3	1	.0564	.0568	.05673	.4917E-07
		2	.0569	.0568		

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 81-6

BARTLETT'S TEST FOR HOMOGENEITY OF BOTTLE VARIANCE

CALCULATED STATISTIC	34.588
CHI-SQUARE(.95,27)	40.119

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DOORNBOS' TEST FOR BOTTLE MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR TWO-WAY ANOVA

AU 2	ZERO WITHIN-BOTTLE VARIANCE

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 81-6

TWO-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	13	.23279308E-03	.17907160E-04
BETWEEN BOTTLES	14	.78352250E-05	.55965893E-06
WITHIN BOTTLES	28	.51875250E-04	.18526875E-05
TOTAL	55	.29250356E-03	

F-CALC = .302 F-CRIT(.95;14,28) = 2.064

TEST SAMPLE IS HOMOGENEOUS

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 81-6

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	35.849
CHI-SQUARE(.95,14)	23.691

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

NONE REJECTED

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 81-6

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	14	.24106358E-03	.17218827E-04
WITHIN LABS	45	.59960475E-04	.13324550E-05
TOTAL	59	.30102406E-03	

REPEATABILITY VARIANCE	.13324550E-05
REPEATABILITY STD. DEV.	.00115432
BETWEEN-LABORATORIES VARIANCE	.39715931E-05
BETWEEN-LABORATORIES STD. DEV.	.00199289
REPEATABILITY	.00326673
PERMISSIBLE TOLERANCE BETWEEN LABS	.00609457
GRAND MEAN	.05586083
VARIANCE OF THE GRAND MEAN	.28698046E-06

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 85-13

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS CHROMIUM		LAB MEAN	LAB VARIANCE
1	AU 1	1	.0151	.0156	.01512	.1217E-06
		2	.0148	.0150		
2	AU 2	1	.0162	.0164	.01620	.2667E-07
		2	.0160	.0162		
3	FR 1	1	.0165	.0156	.01598	.2492E-06
		2	.0163	.0155		
4	FR 2	1	.0165	.0170	.01695	.9667E-07
		2	.0172	.0171		
5	IT 1	1	.0170	.0170	.01650	.3333E-06
		2	.0160	.0160		
6	IT 2	1	.0175	.0170	.01675	.7500E-06
		2	.0170	.0155		
7	JP 1	1	.0160	.0156	.01553	.1292E-06
		2	.0152	.0153		
8	JP 2	1	.0172	.0169	.01685	.8333E-07
		2	.0168	.0165		
9	JP 3	1	.0162	.0167	.01638	.1092E-06
		2	.0160	.0166		
10	JP 5	1	.0167	.0172	.01683	.8917E-07
		2	.0165	.0169		
11	JP 6	1	.0161	.0161	.01615	.3000E-07
		2	.0164	.0160		
12	NL 1	1	.0161	.0159	.01595	.1667E-07
		2	.0160	.0158		
13	SU 1	1	.0171	.0177	.01745	.9000E-07
		2	.0173	.0177		
14	SU 2	1	.0168	.0155	.01613	.5225E-06
		2	.0167	.0155		
15	SU 3	1	.0165	.0163	.01648	.5583E-07
		2	.0163	.0168		

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 85-13

BARTLETT'S TEST FOR HOMOGENEITY OF BOTTLE VARIANCE

CALCULATED STATISTIC	17.613
CHI-SQUARE(.95,25)	37.660

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DOORNBOS' TEST FOR BOTTLE MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR TWO-WAY ANOVA

IT 1	ZERO WITHIN-BOTTLE VARIANCE
JP 6	ZERO WITHIN-BOTTLE VARIANCE

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 85-13

TWO-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	12	.19156477E-04	.15963731E-05
BETWEEN BOTTLES	13	.20175000E-05	.15519231E-06
WITHIN BOTTLES	26	.50025000E-05	.19240385E-06
TOTAL	51	.26176477E-04	

F-CALC = .807 F-CRIT(.95;13,26) = 2.119

TEST SAMPLE IS HOMOGENEOUS

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 85-13

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	21.046
CHI-SQUARE(.95,14)	23.691

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 85-13

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	14	.19406360E-04	.13861686E-05
WITHIN LABS	45	.81100000E-05	.18022222E-06
TOTAL	59	.27516360E-04	

REPEATABILITY VARIANCE	.18022222E-06
REPEATABILITY STD. DEV.	.00042453
BETWEEN-LABORATORIES VARIANCE	.30148659E-06
BETWEEN-LABORATORIES STD. DEV.	.00054908
REPEATABILITY	.00120141
PERMISSIBLE TOLERANCE BETWEEN LABS	.00177095
GRAND MEAN	.01634800
VARIANCE OF THE GRAND MEAN	.23102810E-07

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 85-14

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS CHROMIUM		LAB MEAN	LAB VARIANCE
1	AU 1	1	.0161	.0174	.01658	.5362E-06
		2	.0159	.0169		
2	AU 2	1	.0181	.0181	.01855	.8100E-06
		2	.0199	.0181		
3	FR 1	1	.0185	.0195	.01893	.2558E-06
		2	.0185	.0192		
4	FR 2	1	.0191	.0184	.01878	.1425E-06
		2	.0185	.0191		
5	IT 1	1	.0200	.0205	.01975	.4167E-06
		2	.0190	.0195		
6	IT 2	1	.0190	.0205	.02050	.1500E-05
		2	.0220	.0205		
7	JP 1	1	.0190	.0185	.01843	.1892E-06
		2	.0180	.0182		
8	JP 2	1	.0190	.0188	.01875	.1433E-06
		2	.0190	.0182		
9	JP 3	1	.0190	.0178	.01825	.2967E-06
		2	.0183	.0179		
10	JP 5	1	.0184	.0185	.01855	.1667E-07
		2	.0186	.0187		
11	JP 6	1	.0184	.0183	.01815	.1367E-06
		2	.0176	.0183		
12	NL 1	1	.0182	.0178	.01785	.5667E-07
		2	.0177	.0177		
13	SU 1	1	.0187	.0190	.01903	.1158E-06
		2	.0195	.0189		
14	SU 2	1	.0188	.0178	.01828	.3692E-06
		2	.0188	.0177		
15	SU 3	1	.0185	.0182	.01845	.3100E-06
		2	.0179	.0192		

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 85-14

BARTLETT'S TEST FOR HOMOGENEITY OF BOTTLE VARIANCE

CALCULATED STATISTIC	16.711
CHI-SQUARE(.95,25)	37.660

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DOORNBOS' TEST FOR BOTTLE MEANS (ALPHA=.05)

IT 2 BOTTLE- 2 T-CALC = 3.572 T-CRIT(.00167,28) = 3.479

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR TWO-WAY ANOVA

AU 2	ZERO WITHIN-BOTTLE VARIANCE
IT 2	DOORNBOS' TEST FOR BOTTLE MEANS
NL 1	ZERO WITHIN-BOTTLE VARIANCE

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 85-14

TWO-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	11	.24355092E-04	.22140992E-05
BETWEEN BOTTLES	12	.21081000E-05	.17567500E-06
WITHIN BOTTLES	24	.66780000E-05	.27825000E-06
TOTAL	47	.33141192E-04	

F-CALC = .631 F-CRIT(.95;12,24) = 2.183

TEST SAMPLE IS HOMOGENEOUS

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 85-14

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	19.039
CHI-SQUARE(.95,14)	23.691

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

AU 1	R =	.642	D-CRIT(15) =	.565
IT 2	R =	.656	D-CRIT(14) =	.587

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

AU 1	DIXON'S TEST FOR LABORATORY MEANS
IT 2	DIXON'S TEST FOR LABORATORY MEANS

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 21B 1986 --- NI/CR BY FLAME AAS METHOD --- CHROMIUM
SAMPLE: 85-14

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	12	.10850769E-04	.90423077E-06
WITHIN LABS	39	.97775000E-05	.25070513E-06
TOTAL	51	.20628269E-04	

REPEATABILITY VARIANCE	.25070513E-06
REPEATABILITY STD. DEV.	.00050070
BETWEEN-LABORATORIES VARIANCE	.16338141E-06
BETWEEN-LABORATORIES STD. DEV.	.00040420
REPEATABILITY	.00141699
PERMISSIBLE TOLERANCE BETWEEN LABS	.00152067
GRAND MEAN	.01859423
VARIANCE OF THE GRAND MEAN	.17389053E-07